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Discounting Property-Liability Loss Reserves

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Abstract

The 1986 Tax Reform Act requires property-liability insurers to discount loss reserves at a set rate to determine tax liabilities. Conversely, statutory accounting standards do not permit discounting of loss reserves in most instances. Properly applied, discounting of loss reserves establishes a market value for loss reserves that reflects the economic value of these liabilities. This market value accounting principle is the basis of much of the research on pricing insurance contracts. This paper reviews the current and newly required procedures for valuing loss reserves, examines the advantages and disadvantages of discounting and proposes a theoretical approach to determining the proper discount rate that is derived from the financial pricing models applied to pricing property-liability insurance contracts.

I. Introduction

Discounting loss reserves is, in essence, establishing the market value of outstanding losses. It may seem unusual to consider setting a market value for an item that is first, a liability, and second, not generally traded. However, liabilities are often treated as negative assets in the financial literature [15]. Simply treating loss reserves as an asset, but including a negative sign in any calculations, addresses the first issue. As for the second issue, sales of loss reserves do occur. In 1983 an estimated 40 transactions involving selling loss reserves occurred. In one case Fireman's Fund paid $43 million to INA to assume an estimated $109 million in workers' compensation reserves. At the same time INA paid Fireman's Fund $40 million to assume $116 million of workers' compensation reserves [31]. These transactions typically involve reinsurance, with the reinsurer assuming a loss liability [30]. The exchanges do not occur at the stated value of the loss reserves, but at a mutually agreed market value of the liability. Thus, loss reserves represent a marketable negative asset that can be priced based on standard pricing models with minor adjustments.

A prolific area of research over the past decade has involved the inclusion of investment income in pricing insurance. Several researchers have attempted to measure the systematic risk of underwriting in total or by line to determine the proper risk loadings that should be included in insurance rates. The logic behind all of these models has been that assets and liabilities should be based on economic or

market value accounting rather than book or statutory values. In order to apply these models correctly, loss reserves, the major component of liabilities, need to be stated at the market, or discounted, value.

This paper will cover the current procedure for valuing outstanding losses, the motivation for changing the current procedure and a theoretical analysis of the issues involved in determining the market value of loss reserves. The prior literature on estimating the systematic risk of underwriting and liabilities will be summarized and compared with this approach. As discounting is not generally applied to loss reserves, the actuarial notation for reserving does not lend itself to a discussion of discounted loss reserves. To facilitate such a discussion, a revised notation for reserving will be presented.

II. Current Reserving Procedures

The current method of valuing loss reserves for property-liability insurers is to sum the estimates of all future payments for losses that have already occurred. The loss reserve includes: (1) losses that have been reported, investigated and assigned a case estimate for those particular claims; (2) losses that have been reported too recently to allow for a thorough investigation; and (3) losses that, although they have already occurred, have not yet been reported to the insurer. Some losses will be settled in a matter of days after the evaluation date, whereas other losses could take decades to settle. Except for annuity payments under workers' compensation claims, the time value of money is ignored in setting the loss reserve.

The current method for valuing loss reserves is akin to valuing a bond as the undiscounted sum of all future interest payments plus the

principal at maturity. This method of valuing a bond would, obviously, overstate the true market value and, since bonds represent assets, unrealistically inflate the net worth of the firm. However, loss reserves represent liabilities and overstating these values by claiming the undiscounted total of future payments results in artificially low earnings and net worth for insurers. Statutory insurance accounting, established by the state insurance regulators, is meant to be conservative. Bankruptcy is a major concern to insurance regulators, but reduced earnings and an understatement of asset value are less of a problem. As loss reserves are only estimates of future loss payments, establishing the liability as the undiscounted sum of future payments is a means of being conservative. States generally collect tax revenue from the insurance industry through a tax on premiums which is not affected by discounting loss reserves or profitability. Thus, understating insurer profitability does not affect state tax revenue in the manner that Federal tax revenue is reduced.

Inertia also plays an important role in the loss reserve methodology. Current loss reserving regulations are inherited from an era when property-liability insurers were primarily property insurers. Property claims are settled quickly, in contrast to liability claims that can take years to settle. Also, interest rates were low in the years insurance regulation was being developed. Discounting loss reserves under low interest rates and rapid claim settlements would simply not make much of a difference. Prior to the Tax Reform Act of 1986, tax policy was determined by provisions in the Revenue Act of 1921 that based the gross income definition on statutory accounting conventions. Today, with

higher interest rates and long payout periods, discounting makes a tremendous difference. Insurance regulation had not kept pace with events.

III. Discounting: Pros and Cons

The impetus for changing loss reserve accounting conventions is not coming from insurance regulators or from insurers, but from the Federal government. In aggregate, the property-liability insurance industry has incurred negative taxes over the last four years, as statutory accounting conventions have created tax losses that allowed recovery of taxes paid in prior years. In order to raise revenue from the insurance industry, several proposals were advanced at the Federal level to discount loss reserves. The General Accounting Office proposed that insurers discount loss reserves by the average pre-tax investment income rate achieved by each insurer over the prior five years [13]. The Treasury Department proposed the establishment of qualified reserve accounts (QRA) as a method of discounting loss reserves [34]. The final tax reform bill that emerged from the House-Senate conference committee included a provision for discounting loss reserves at the five year historical average of mid-maturity U.S. government obligations [4]. In the final bill passed by the House of Representatives and the Senate, loss and loss adjustment expenses are to be discounted for tax purposes based on 100 percent of the applicable Federal midterm interest rate on a five year rolling average basis. Loss payment patterns by line are to be promulgated by the Treasury Department, although insurers can elect to use their own loss payment patterns. Discounting is effective for taxable years beginning after 1986 [25]. Discounting loss reserves

applies only to the determination of taxable income, and not to statutory reporting. However, now that the Federal government has adopted discounting, state regulators may incorporate discounting to reduce the need for insurers to maintain two sets of financial data.

The primary advantage of discounting loss reserves, from the standpoint of its chief proponent, the Federal government, is that tax revenues will be increased. For insurers this effect is a disadvantage. Other effects that can be more universally viewed as beneficial are that discounting reflects the time value of money, restores the usefulness of the combined ratio as a profitability benchmark and increases the surplus and capacity of the industry. The time value of money is a basic tenet of finance and a crucial factor in financial markets. Statutory accounting provisions applied to the insurance industry disregard the time value of money. As a financial institution this disregard for financial conventions is perplexing. Discounting loss reserves for statutory reports would serve to correct this dichotomy.

The combined ratio is often used as a quick test of profitability for a line of business or a company. To reflect the timing difference between expenses, which are generally incurred when premiums are collected, and losses, which develop over the exposure period of the contract, the combined ratio is the sum of the expense ratio (underwriting expenses/written premium) plus the loss ratio (incurred losses/earned premium). Values below 100 percent are considered to be profitable and values above this "breakeven" benchmark are considered unprofitable. However, differences in loss payout patterns and changes in interest rates over time have served to make the standard benchmark irrelevant

[21]. Comparisons between lines cannot be made due to the different loss payout patterns; comparisons of the same line over time are also inappropriate due to changes in the discount rate. Discounting loss reserves at an appropriate level and using the discounted reserves to calculate the incurred loss ratio would reestablish the combined ratio as a valid profitability measure.

For analyzing the insurer in total, the operating ratio is often used in lieu of the combined ratio. The operating ratio equals the combined ratio less investment income divided by earned premium. The operating ratio has several deficiencies. First, by line operating ratios are based on arbitrary allocations of investment income to lines of business and do not reflect realistic investment earnings generated by an individual line. Second, capital gains and losses, both realized and unrealized, are not included in the investment income value so the operating ratio does not reflect all investment income. Finally, insurance accounting does not require insurers to recognize market gains and losses on bond investments so the portfolio return represents a weighted average of prior years' interest rates that do not necessarily reflect current interest rates. For these reasons it would be preferable to reestablish the combined ratio as a profitability measure than to utilize the operating ratio.

Discounting loss reserves at a positive interest rate would reduce these liabilities and, therefore, increase the net worth, or surplus, of the insurer. As insurers and regulators often seek to maintain the ratio of premiums to surplus below a predetermined target, any increase in surplus would allow insurers to write an increased amount of

premiums, thus generating greater capacity for the industry. The reliance on premium to surplus ratios by regulators is rather arbitrary. Insurance accounting includes several distortions that affect stated surplus values. The unearned premium reserve is established at the prorata portion of written premiums to reflect coverage that has not expired. Expenses are generally paid when the coverage is written, so only losses are likely to emanate from unearned coverage. However, no credit is given to insurers for this equity in the unearned premium reserve. Similarly, interest rate changes cause the market value of bonds to diverge from book value, but no adjustments are made to reflect this difference in allowable premium to surplus ratios. The effect of discounting the loss reserves of liability insurers would be greater than the effect for property insurers, but both are held to similar premium to surplus ratios now. Thus, an accounting change to value loss reserves at market value would have the effect of allowing insurers to write more premium income.

During 1985 and 1986 many insurance buyers have had difficulty obtaining certain types of insurance coverage, especially directors' and officers', pollution and product liability. These coverages are more difficult to price than other lines and insurers with limited capacity are choosing to avoid these coverages. If the surplus of individual insurers, and the industry in aggregate, were recognized to be higher than statutory values currently indicate, a greater premium volume could be written. Coverage that is difficult or impossible to place in the current market crunch may be provided for under the increased insurance capacity.

A number of disadvantages of discounting exist. First, discounting would significantly increase the complexity of loss reserving. Currently actuaries need to forecast only the sum of all future loss payments for losses that have already occurred without regard to the timing of the payments. Under discounting the timing must be predicted and the proper discount rate applied. If losses are paid earlier than projected or if the discount rate applied is too high, the established loss reserve would be inadequate. Currently actuaries do not have to be concerned about either of these factors. However, even under the current system loss reserves are not accurate. Numerous studies describe the inaccuracies of loss reserves [1, 2, 12, 29 and 33]. If the process is made more complex, the accuracy of future estimates is likely to deteriorate even further.

Another problem in discounting loss reserves is the reduced ability to monitor loss reserve adequacy. One advantage of the current system is that it is relatively easy to determine the accuracy of past loss reserve levels. The actual losses paid out over a several year period plus any remaining outstanding reserves can be compared with the established loss reserves to determine if the initial reserves were adequate. Although the actual paid loss development can still be compared with the initial undiscounted reserve after discounting is adopted, it will not be a valid test of reserve accuracy. Under discounting actuaries must project both the amount of the loss and the timing of loss payments. Retrospective reserve analysis will be more difficult under discounting. Rather than comparing the sum of paid losses plus outstanding reserves to the initial loss reserve, monitoring reserve accuracy will involve analyzing an entire payout matrix of projected

and actual loss payout data. Errors can be caused by payment timing or interest rate changes. Based on agency theory, any reduction in the ability to monitor results is likely to affect the performance of individuals involved in setting loss reserves [20].

As discounting is intended to derive increased tax revenue from the insurance industry for the Federal government, it is likely to lead to higher prices. Insurers will alter their investment strategies to cope with the revised tax provisions. Portfolio adjustment will be costly and the after tax returns from the revised investment portfolios are likely to be lower than current returns. Also the retraining involved in shifting to a new reserving procedure will be costly, again leading to an increase in insurance prices. An additional disadvantage of discounting is that reserve adequacy becomes dependent on interest rate levels, so a drop in interest rates could adversely affect the solvency of an insurer.

Despite the relative advantages and disadvantages of an insurer, the self interest of the U.S. government has been the determining factor in the decision to adopt discounting. Thus, the insurance industry will be discounting loss reserves at least for tax purposes. The current concern is now how, not whether, discounting should be applied.

IV. Revised Notation

As currently actuaries need not be concerned about the timing of future loss payments, some modifications in loss reserving notation must be introduced to discuss discounting adequately. In this paper the following notation will be used:

$P_{i,j}$ = accident year i losses paid in development year j

${}_t\hat{P}_{i,j}$ = estimate as of the end of year t of accident year i losses to be paid in development year j

d_t = annual discount rate applied to loss reserves as of the end of year t

${}_tDLR_i$ = discounted loss reserve as of the end of year t for accident year i

${}_tDLR$ = total discounted loss reserve as of the end of year t

$r_{DLR,t}$ = rate of return on discounted loss reserves in year t

The accident year is the year in which the loss occurs, although it may be paid in subsequent years. The development year represents when the loss is paid in relation to when the loss occurred. Losses paid in the first development year are paid in the same year that the loss occurred.

The notation for actual and projected paid losses is illustrated in the familiar loss development triangle format in Figure 1. This figure represents the historical and projected loss payouts for a line of business with a six year runoff as of the end of 1985. The values of P (without the hat) are known values. The $\hat{P}$ values are estimates. The total undiscounted loss reserve for accident year 1985 is the sum of ${}_{85}\hat{P}_{85,j}$ for j=2 through 6. The total undiscounted loss reserve is the sum of all the $\hat{P}$ values on Figure 1. The diagonal of ${}_{85}\hat{P}_{85,2}$ to ${}_{85}\hat{P}_{81,6}$ represents losses that are expected to be paid within one year of the evaluation date, which means they should be paid during 1986. The value ${}_{85}\hat{P}_{85,6}$ is expected to be paid in five years, or 1990.

Insert Figure 1 here

The losses to be paid in each year will be paid throughout the year in a declining, although somewhat seasonal, pattern. Determining the proper fractional exponent for discounting is discussed in some detail by Salzmann [27]. To simplify the presentation of the theory, the assumption that all losses are paid at the end of each development year is made. This avoids the need for fractional exponents.

The total discounted loss reserve at the end of year t is determined by:

$$(1) \qquad {}_{t}DLR = \sum_{i=0}^{n-2} \sum_{j=i+2}^{n} \frac{{}_{t}\hat{P}_{t-i,j}}{(1+d_t)^{j-i-1}}$$

Losses expected to be paid in one year are discounted by one plus the discount rate. Losses expected to be paid in two years are discounted by one plus the discount rate squared, and so forth.

The rate of return during year t+1 is determined as follows:

$$(2) \qquad r_{DLR,t+1} = -[\frac{(\sum_{i=0}^{n-2} P_{t-i,i+2}) + {}_{t+1}DLR - {}_{t+1}DLR_{t+1}}{{}_{t}DLR} - 1]$$

The rate of return is multiplied by minus one since the liability is being treated as a negative asset. The actual losses paid during the first year after the evaluation date are added to the current discounted losses for all years except accident year t+1 which was not included in the initial discounted loss reserve since these losses had not occurred as of the initial evaluation date. This sum is divided by the initial discounted loss reserve. One is subtracted from the quotient to determine the rate of return. The discounted loss reserve is expected to earn a rate of return similar to, although with the negative sign, any investment asset.

V. Comparative Statics

The actual rate of return achieved on the discounted loss reserve is shown in equation (2). The expected rate of return on the discounted loss reserves is:

$$(3) \qquad E(r_{DLR,t+1}) = -d_t$$

However, the actual rate of return on the discounted loss reserve will not always equal the negative of the discount rate. The actual rate will equal the expected rate if all the following conditions hold:

$$d_{t+1} = d_t$$

$$P_{t-i,i+2} = {}_t\hat{P}_{t-i,i+2} \text{ for } i=0,1,\ldots,n-2$$

$${}_{t+1}\hat{P}_{t-i,j} = {}_t\hat{P}_{t-i,j}$$

The partial derivatives of r_{DLR} with respect to changes in only d or only P can be determined.

$$\frac{\partial r_{DLR}}{\partial d} > 0$$

$$\frac{\partial r_{DLR}}{\partial P} < 0$$

If the discount rate were to increase, but all estimates of loss payments were unchanged (or lowered), then the rate of return on the discounted loss reserve would increase. This is similar, although opposite in sign, to the effect of an interest rate increase on the rate of return on a bond. The coupon payments on a bond do not change as a result of an increase in market interest rates, but the market value of the bond decreases, reducing the bond rate of return. Conversely, an increase in the discount rate, if the loss payments are

unchanged, increases the rate of return on the loss reserves due to the negative sign involved in the calculation for a negative asset.

If the discount rate were unchanged (or reduced), but the loss payments exceed the estimate or the estimate for future loss payments increases, the rate of return on the discounted loss reserve would decrease. Larger loss payments than expected reduce the return on the negative asset.

If both the discount rate and the loss payouts were to increase or decrease, the effect on the rate of return cannot be signed by comparative statics. An empirical study would be required to determine which effect, the discount rate change or the loss payment change, would dominate. Unfortunately, joint changes are most likely as both interest rates and insurance claim payments are affected similarly by inflation. An increase in the inflation rate is expected to increase interest rates as propounded by Irving Fisher [10] and demonstrated by numerous researchers [5 and 14]. The effect of changes in the inflation rate on loss payments has been both theoretically developed and empirically tested in several instances [6 and 33]. The stochastic nature of loss reserves and the positive covariance between loss reserves and inflation prevent the implementation of immunization strategies using conventional financial instruments. Increases in inflation would reduce the value of bonds and increase the loss payouts.

An empirical test of the joint effect of discount rate changes and loss payout patterns would require loss payout estimates, which are not provided for under the regime of undiscounted loss reserves. Thus, the information is not available to determine the overall effect of changes

in loss payout patterns and the discount rate on the rate of return for discounted losses.

VI. Asset Pricing Models

In the effort to determine the market price of loss reserves an asset pricing model used to price other capital assets could be applied. The most commonly used pricing model is the capital asset pricing model (CAPM) [22, 23 and 28]. This pricing model was derived in the 1960s and stood as the accepted model for over a decade until anomalies and other challenges cast some doubt over its universality [16, 26 and 32]. Although currently accepted as an imperfect pricing model, the CAPM is a useful approximation and a valid starting point for pricing loss reserves.

The basic format of the CAPM is:

$$E(r_i) = r_F + \beta_i(E(r_M) - r_F) \tag{4}$$

where r_i = return on asset i

r_F = risk free rate of return

r_M = return on the market portfolio

β_i = covariance of the return on asset i and the return on the market portfolio

This formulation indicates that the expected return on an asset is the risk free rate of return plus the beta times the market risk premium. As investors are assumed to hold diversified portfolios, diversifiable risk, defined as any risk that is not systematic with market risk, is not priced in the market. Only systematic risk must be compensated by a higher return.

The market risk premium, or the excess returns of the market over the risk free rate, has been variously measured at between 6 and 9 percentage points [11 and 19]. The risk free rate is often approximated by the short term U.S. Treasury bill rate, currently in the range of 5 to 6 percent. Beta can be positive or negative, and can have an absolute value below, equal to or above one. Beta of the market as a whole is, by definition, equal to one.

William Fairley wrote one of the first applications of the CAPM to insurance pricing [9]. Assuming market value accounting led to the following relationships:

(5) $$V_E = V_A - V_L$$

where V_E = market value of equity

V_A = market value of assets

V_L = market value of liabilities

(6) $$r_E V_E = r_A V_A - r_L V_L$$

where r_E = return on equity

r_A = return on assets

r_L = return on liabilities

(7) $$\beta_E = \beta_A(ks + 1) + \beta_P s$$

where β_E = systematic risk of the insurer's equity

β_A = systematic risk of the insurer's assets

β_P = systematic risk of underwriting

k = average amount of investable funds created by the cash flow per dollar of annual premium

s = premium to capital (equity) ratio

Equation (5) indicates that the market value of the firm's equity is the market value of assets less the market value of liabilities. Equation (6) indicates that the return on equity is the difference between the return on assets and the return on liabilities. Equation (7) demonstrates that the riskiness of the equity in total is the sum of the risk on investable assets weighted by the value of the assets and the risk of underwriting weighted by the premium to capital ratio.

The use of accounting measures of underwriting profit margins produce values of β_P generally near zero, as reported by Hill [17]. Fairley recognized that statutory underwriting profit margins do not realistically portray insurance profitability. To circumvent this problem, he calculated a beta on liabilities generated by the insurance coverage written, which would include loss reserves and unearned premium reserves. The relationship between the underwriting beta and the liability beta is:

(8) $$\beta_P = -k\beta_L$$

Substituting equation (8) into equation (7) and adding a term to reflect taxes leads to:

(9) $$\beta_E = (1-t)(\beta_A(ks + 1) - ks\beta_L)$$

where t = the insurer's tax rate

Substituting industry averages for t, k, s, β_E and β_A based on available data, Fairley determined that $\beta_L = -.21$. This value of systematic risk is applied to the CAPM based underwriting profit margin model:

$$(10) \quad p = -kr_F - k\beta_L(r_M - r_F)$$

where p = underwriting profit margin

Use of industry averages leads to an appropriate underwriting profit margin of approximately negative 3 percent.

However, several problems with his choice of data exist. Hill and Modigliani [18] point out that Fairley ignores the value of non-traded assets in selecting β_A, which, if properly included, would increase β_L. Another problem is that market value accounting is assumed in deriving the relationships, but insurer surplus is taken from book value figures. If liabilities were valued at the market value, loss reserves would be discounted which would increase surplus. D'Arcy [8] measures the impact of discounting loss reserves on surplus for industry aggregate data for 1983 to be an increase of 24 to 41 percent based on discount rates of 5 and 10 percent respectively. Correcting the value of s based on this adjustment would increase the industry average underwriting profit margin determined by equation (10) from negative 3 percent to negative 2 or 1 percent, based on either a 5 or 10 percent discount rate.

Myers and Cohn [24] develop a simplified alternative to the Fairley model based on present value accounting. This approach avoids the need for many of the assumptions and approximations made by Fairley. Present value accounting requires the use of an appropriate discount rate, which Myers and Cohn calculate based on the CAPM. Their model is not dependent on the CAPM, though. The results of the present value model are compared with Fairley's model and found to generate significant differences. Despite the direct recognition of present value accounting, no adjustment is made for the effect of discounting loss reserves on surplus.

Cummins and Harrington [7] also analyze underwriting betas. Their study is based on quarterly profit data for 14 property-liability insurers. The results indicate that underwriting betas are not stationary and vary among insurers. Although the difference between real and nominal values for losses is recognized and the time value of money is considered in examining the expected relationship between underwriting profits and the risk free rate, the authors were constrained to use undiscounted loss values due to data availability.

Kahane and Porat [21] demonstrate the effect of mismatching the timing of cash flows in measuring property-liability loss ratios and profitability measures. Although ignoring the issue of risk adjustment, this article presents a strong case for adopting a present value approach in calculating loss ratios.

The focus of the current paper is to determine the appropriate discount rate for loss reserves based on the CAPM. Once the proper market value of loss reserves is determined, many of the intractable problems in determining underwriting betas become solvable. Thus, discounting loss reserves can serve both the present value problems addressed by Kahane and Porat and Myers and Cohn, as well as the underwriting risk problems addressed by Fairley, Hill, and Cummins and Harrington.

VII. Calculating the Discounted Loss Reserve

The CAPM can be applied to determine the appropriate risk adjusted discount rate. To use the CAPM, equation (4) is restated as:

$$(11) \qquad E(r_{DLR}) = -[r_F + \beta_{DLR}(E(r_M) - r_F)]$$

where β_{DLR} = covariance of r_{DLR} and r_M

The right hand side of this equation is negative because the discounted loss reserves are treated as a negative asset. The expected rate of return on the discounted loss reserves is equal to the negative discount rate, from equation (3). Thus, the appropriate discount rate based on the CAPM is:

$$(12) \qquad d_t = r_F + \beta_{DLR}(E(r_M) - r_F)$$

From this equation, the appropriate discount rate for discounting loss reserves could be the risk free rate if β_{DLR} were zero. If β_{DLR} = $(-r_F/(E(r_M)-r_F))$ (the negative quotient of the risk free rate divided by the market risk premium), then the appropriate discount rate would be zero. If β_{DLR} is less than the negative quotient of the risk free rate divided by the market risk premium, the appropriate discount rate is negative, which means that discounted loss reserves would exceed the current undiscounted values. For any positive values of β_{DLR}, the appropriate discount rate is greater than the risk free rate; negative β_{DLR} values produce a discount rate below the risk free rate.

The appropriate discount rate, d_t, depends on β_{DLR}, and the determination on β_{DLR} is based on values of the discounted loss reserve that are determined based on a discount rate, but the values are not determined by use of a simultaneous equations system. The appropriate discount rate to apply to the current loss reserves is based on the current β_{DLR} (equation 12). Values of β are traditionally determined based on past covariance between an asset's return (equation 2) and the market return, and therefore would be based on past discount rates. Also, both

the market risk premium and the risk free rate of return affect the appropriate discount rate, and these values vary over time.

The first step in solving this system of equations is to discount past loss reserves based on the risk free rate. The short term U.S. Treasury bill rate (three or six month new issues) is commonly used to approximate the risk free rate in a one period model. Loss payout patterns and the discounted loss reserves, combined as indicated in equation (2), can be used to generate the rate of return earned on the discounted loss reserve as a negative asset. The covariance of this rate of return over time with the market rate of return (as proxied by the Standard & Poor's 500 or any other broad market index) can then be calculated, and this represents an initial estimate of β_{DLR}. If this value of β_{DLR} is not significantly different from zero, then the risk free rate can be accepted as the appropriate discount rate for loss reserves. If β_{DLR} is significantly different from zero, the estimated β_{DLR} value should be applied in equation (12) to determine the historical appropriate discount rates. These second pass discount rates should then be used to establish revised rates of return for the discounted loss reserves, as in equation (2). The revised rates of return would then lead to a new covariance determination to obtain revised estimates of β_{DLR}. The significance of the revised β_{DLR} should be compared both with the initial β_{DLR} estimates and zero, to determine if another iteration is necessary.

In order to calculate β_{DLR} and the appropriate discount rate, d_t, projected loss payment patterns by year and actual loss payment data for at least a ten year period should be used. Currently insurers only report aggregate future loss payments as required by statute. Many

insurers could project loss payouts by period from internal company reports. Reported paid loss development data could also be used to approximate these values. The ideal database would include projected loss payment patterns and loss development data for a large number of individual insurers. However, reasonable values could be estimated based on a single large insurer's experience.

Fairley calculated a beta for liabilities of -0.21 based on the relationship shown in equation (9). The total liabilities of an insurer includes loss and loss adjustment expenses, unearned premium reserves, contingent commissions, unpaid expenses, unpaid taxes, loans, declared but unpaid dividends, reinsurance funds owed and several miscellaneous categories. In 1983 reserves for losses and loss adjustment expenses comprised 60 percent of the industry's aggregate liabilities [3]. The next largest component of surplus was unearned premium reserves, at 21 percent. Unearned premium reserves represent the prorata portion of premiums that relate to unlapsed coverage periods. Although the unearned premium reserve in total may fluctuate in line with economic trends as premium writings increase as markets expand, the value of existing unearned premiums should not depend on market conditions. Thus, liabilities other than the loss reserve (including the loss adjustment expense reserve) are likely invariant with market returns. Assuming that the covariance of the remaining liabilities with the market were zero, then the entire -0.21 determined by Fairley was generated by covariance of loss and loss adjustment expenses with the market. Thus, the β_{DLR} could be estimated at -0.35 (-0.21/.60). Substituting this value of β_{DLR} into equation (12), along with a risk free rate of 6 percent and an excess return on the market of 7.2 percent, yield an

appropriate discount rate of 3.5 percent. This value is admittedly rough, being calculated as the residual risk from approximate determinations of equity and asset betas, but it serves to show how far the appropriate discount rate could differ from the mandated discount rate of midmaturity U.S. government issues as established by the Tax Reform Act of 1986.

VIII. Conclusion

The Tax Reform Act of 1986 will require loss reserve discounting for tax purposes based on the historical interest rate paid on middle maturity U.S. Treasury issues. This is not a theoretically valid rate for several reasons. First, it is not a current market rate, but an historical rate. Insurers may be able to invest at a higher or lower rate, but are constrained to discount at the predetermined rate. Any interest rate volatility will cause this method to be inaccurate. If interest rates are falling, discounted loss reserves will be inadequate. Rapidly rising interest rates will cause the discounted loss reserves to be too high. Second, no consideration is given to the proper adjustment for risk, even if the historical interest rates are the same as current rates. Middle term U.S. Treasury obligations generally earn an interest rate slightly above the short term rate. This adjustment is unlikely to be the proper risk adjustment for loss reserves. Although insurers will be legally required to use this rate in discounting for tax purposes, research should continue to determine the appropriate rate based on financial theory.

The focus of this research should be on determining the market value of loss reserves. This same principle, use of market value accounting

for assets and liabilities, is the basis for much of the research on insurance pricing in recent years. If loss reserves are discounted at the appropriate rate, with the resulting adjustments in surplus, loss ratios and profitability measures, then the measurement of underwriting risk can be made directly from available data without resorting to backing into underwriting risk measures or rough approximations. Discounting loss reserves, if done properly, can solve many of the pricing problems created by statutory accounting distortions.

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FIGURE 1

LOSS DEVELOPMENT TRIANGLE - PAID LOSSES

	DEVELOPMENT YEAR					
ACCIDENT YEAR	1	2	3	4	5	6
1978	$P_{78,1}$	$P_{78,2}$	$P_{78,3}$	$P_{78,4}$	$P_{78,5}$	$P_{78,6}$
1979	$P_{79,1}$	$P_{79,2}$	$P_{79,3}$	$P_{79,4}$	$P_{79,5}$	$P_{79,6}$
1980	$P_{80,1}$	$P_{80,2}$	$P_{80,3}$	$P_{80,4}$	$P_{80,5}$	$P_{80,6}$
1981	$P_{81,1}$	$P_{81,2}$	$P_{81,3}$	$P_{81,4}$	$P_{81,5}$	${}_{85}\hat{P}_{81,6}$
1982	$P_{82,1}$	$P_{82,2}$	$P_{82,3}$	$P_{82,4}$	${}_{85}\hat{P}_{82,5}$	${}_{85}\hat{P}_{82,6}$
1983	$P_{83,1}$	$P_{83,2}$	$P_{83,3}$	${}_{85}\hat{P}_{83,4}$	${}_{85}\hat{P}_{83,5}$	${}_{85}\hat{P}_{83,6}$
1984	$P_{84,1}$	$P_{84,2}$	${}_{85}\hat{P}_{84,3}$	${}_{85}\hat{P}_{84,4}$	${}_{85}\hat{P}_{84,5}$	${}_{85}\hat{P}_{84,6}$
1985	$P_{85,1}$	${}_{85}\hat{P}_{85,2}$	${}_{85}\hat{P}_{85,3}$	${}_{85}\hat{P}_{85,4}$	${}_{85}\hat{P}_{85,5}$	${}_{85}\hat{P}_{85,6}$